

NEW 6 AND 3-CM RADIO-CONTINUUM MAPS OF THE SMALL MAGELLANIC CLOUD. PART I – THE MAPS

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SUMMARY: We present new 6 and 3-cm radio-continuum maps of the Small Magellanic Cloud (SMC), created with the “peeling” technique and a joint deconvolution. The maps have resolutions of $30''$ and $20''$ and r.m.s. noise of 0.7 and 0.8 mJy/beam at 6 and 3 cm, respectively. These maps will be used for future studies of the SMC’s radio source population and overall extended structure.

Key words. Magellanic Clouds, Radio continuum: galaxies, Galaxies: structure

1. INTRODUCTION

In the past two decades, several Parkes, Mopniglo Observatory Synthesis Telescope (MOST) and Australia Telescope Compact Array (ATCA) moderate resolution (\sim arcmin) surveys of the Magellanic Clouds (MCs) have been completed (Filipović et al. 1998).

Deep ATCA and Parkes radio-continuum and snap-shot surveys of the Small Magellanic Cloud (SMC) were conducted at 20, 13, 6 and 3 cm by Filipović et al (2002), achieving sensitivities of 1.8, 0.4, 0.8 and 0.4 mJy/beam respectively. These surveys were conducted in mosaic mode with between 35 and 320 separate pointings using 5 antennae in the 375-m array configuration, with short-spacing information from single-dish Parkes observations. The maps have angular resolutions of $98''$, $40''$, $30''$ and $20''$ at the

respective wavelengths listed above. Recently, we published a set of new high resolution (few-arcsec) radio-continuum mosaic images of the SMC at 20 cm created by combining observations from ATCA and Parkes (Wong et al. 2011). The latest images of the SMC at 6 and 3 cm were presented by Dickel et al. (2005, 2010). These maps display significant artefacts due to the way they were constructed as linear mosaics of individually cleaned images. By jointly deconvolving these data with other archival data we were able to obtain significantly improved maps of the SMC.

2. IMAGING TECHNIQUES

When the area to be imaged exceeds the field of view of the telescope, a mosaic must be made. There are two methods for assembling a mosaic: Image each field and combine the images at the end; or combine the data at the beginning and image them jointly. The field-by-field approach has the advantage that it has modest processing requirements. However, not all available information in the data is utilised. The downside to the joint approach is a huge increase in the processing time and complexity.

A further problem with wide field imaging is the effect of “off-axis” sources. A source that is outside the primary beam of the telescope can still influence the response of the receiver. The solution to this problem is to use the “peeling” technique detailed in Hughes et al. (2007). Essentially, the techniques of self-calibration and source subtraction are used to correct for off-axis sources and thus reduce the artefact levels.

The interferometer images only sample the Fourier plane down to the shortest baseline — the largest scale structures are missed. To correct for this deficiency, archival “zero-spacing” data from Parkes (a large single dish) observations (Filipović et al. 1997) have been incorporated into all of the new survey images. However, these observations do not cover the whole field of the ATCA observations. The Parkes data also have much higher r.m.s. noise than the ATCA data.

Table 1. ATCA Projects used.

Project Code	Dates Observed
C1604	Jun 2007
C1207	February 2005 & 2006
C882	Jun 2000
C859	March 2007
C634	October 1997

3. DATA REDUCTION TECHNIQUE AND RESULTS

The majority of archival data used come from ATCA project C1207 (Dickel et al. 2010), available in calibrated form¹. A search of the Australia Telescope Online Archive² yielded four more projects that cover the SMC at 6 and 3 cm (Table 1). All data were inspected, peeled if necessary, and then combined into a single “dirty map”. The SDI clean algorithm (Sault & Killeen 2010) was used to deconvolve the images, which were then restored. The new maps are presented with and without zero-spacing data in Figs. 1. to 4. The resolutions are 30” and 20” and the sensitivities of the ATCA data are 0.7 and 0.8 mJy/beam at 6 cm (Fig. 1) and 3 cm (Fig. 3), respectively. The r.m.s. noise levels in Figs. 2 and 4 are dominated by the additional noise of the single dish data (Filipović et al. 1997).

As only project C1207 was designed as a survey of the entire region, the maps suffer from nonuniform sensitivity, a consequence of differing integration times at each pointing. Figures 5 & 6 demonstrate how the sensitivity changes across the field.

All these images can be downloaded from <http://spacescience.uws.edu.au/mc/smc/>

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¹<http://www.atnf.csiro.au/research/smc.ctm/>

²<http://atoa.atnf.csiro.au>

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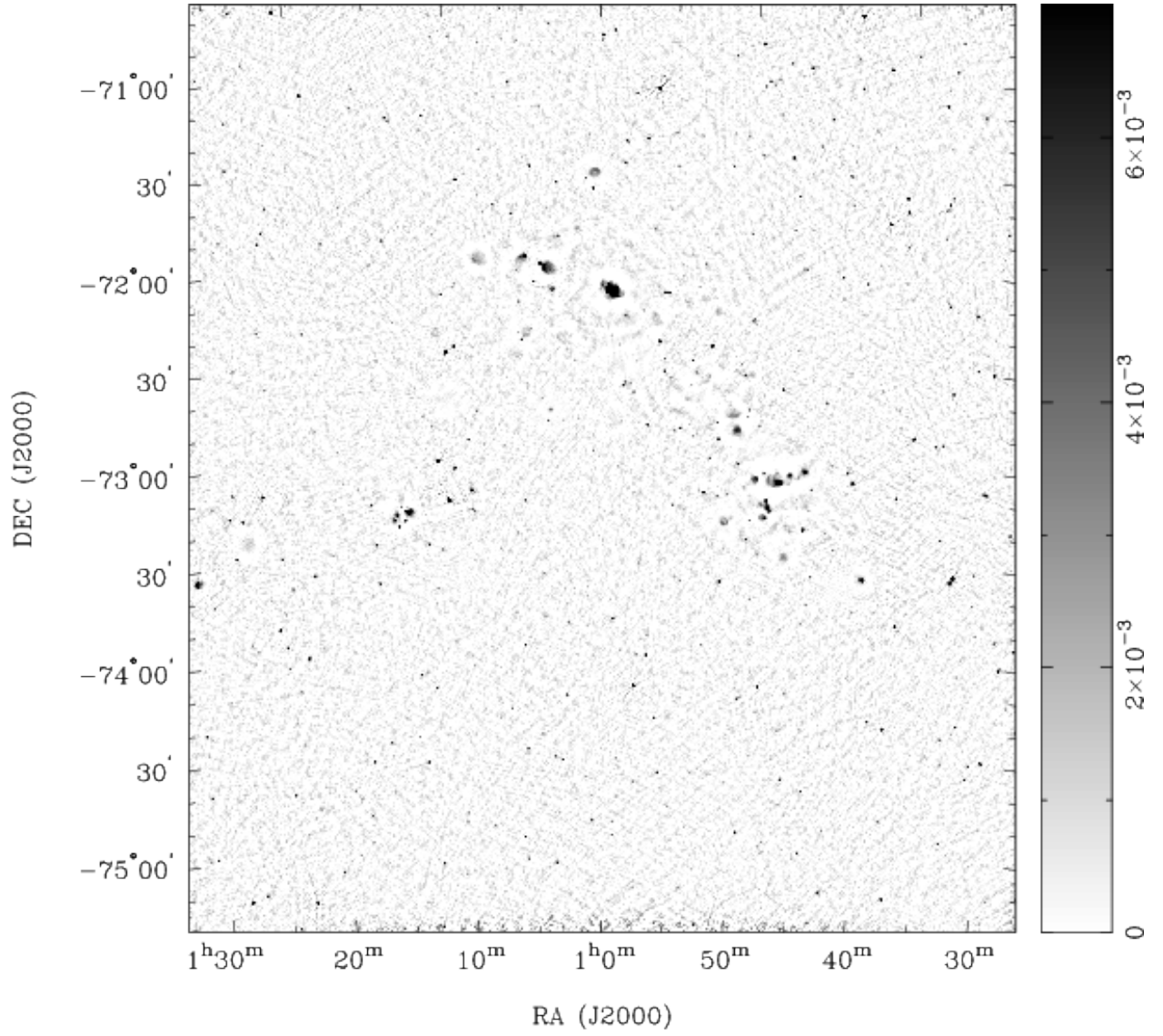


Fig. 1. *The SMC at 6 cm without zero-spacing data. The map has a resolution of 30''. The sidebar gives the intensity scale in units of Jy/beam.*

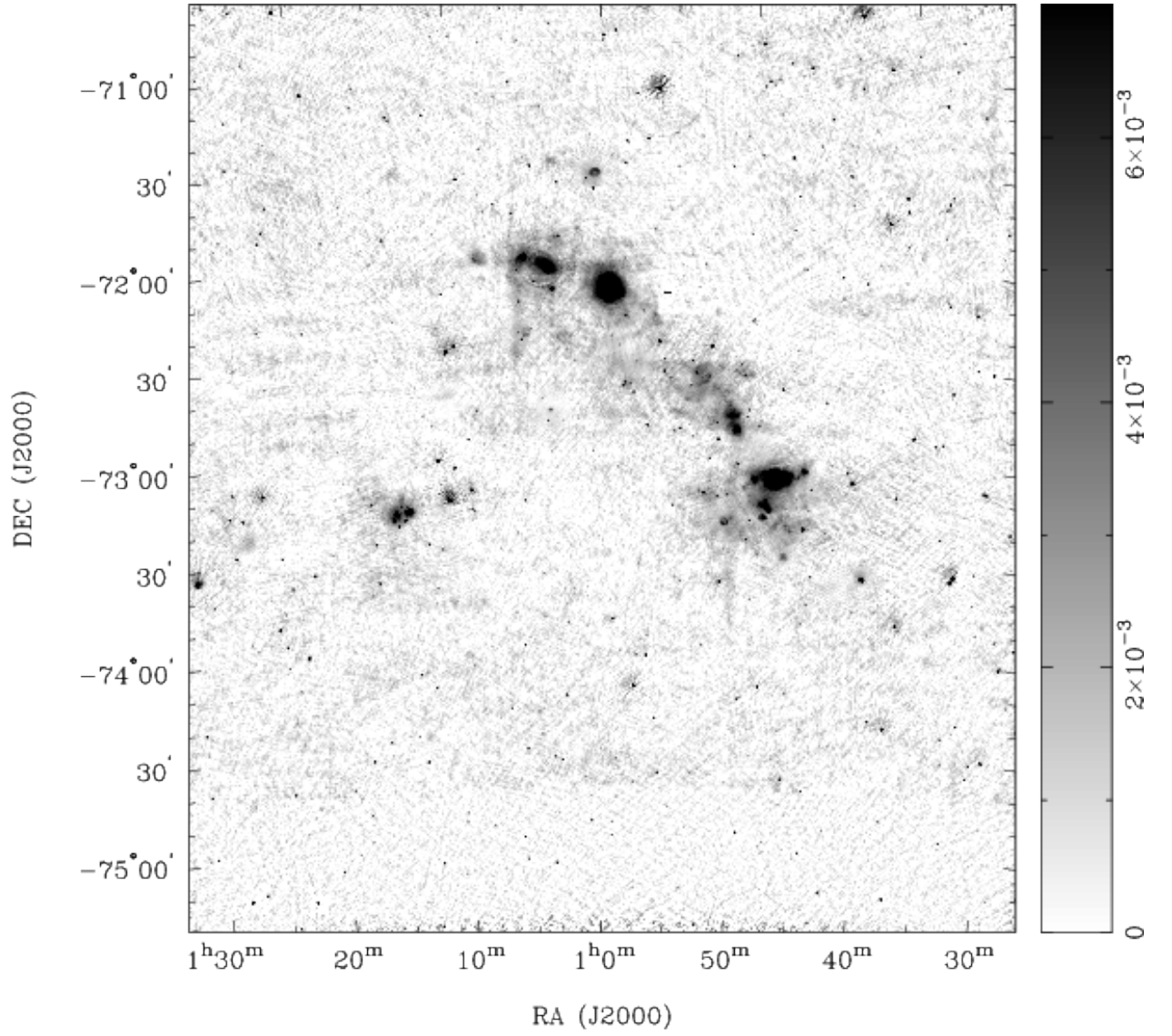


Fig. 2. *The SMC at 6 cm with zero-spacing data. The map has a resolution of 30''. The sidebar gives the intensity scale in units of Jy/beam. The zero-spacing data does not cover the same spatial area as the interferometer data.*

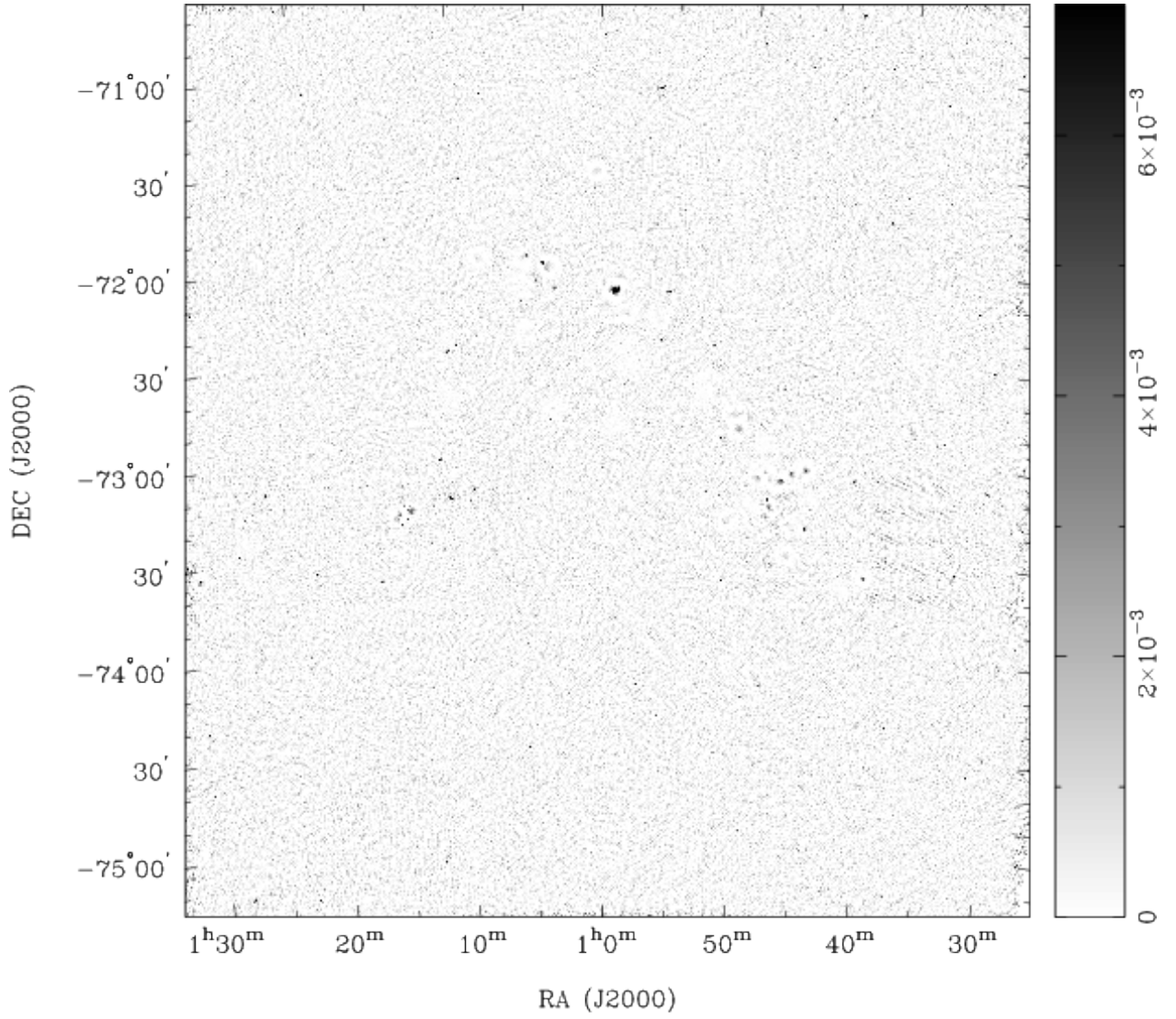


Fig. 3. The SMC at 3 cm without zero-spacing data. The map has a resolution of $20''$. The sidebar gives the intensity scale in units of Jy/beam.

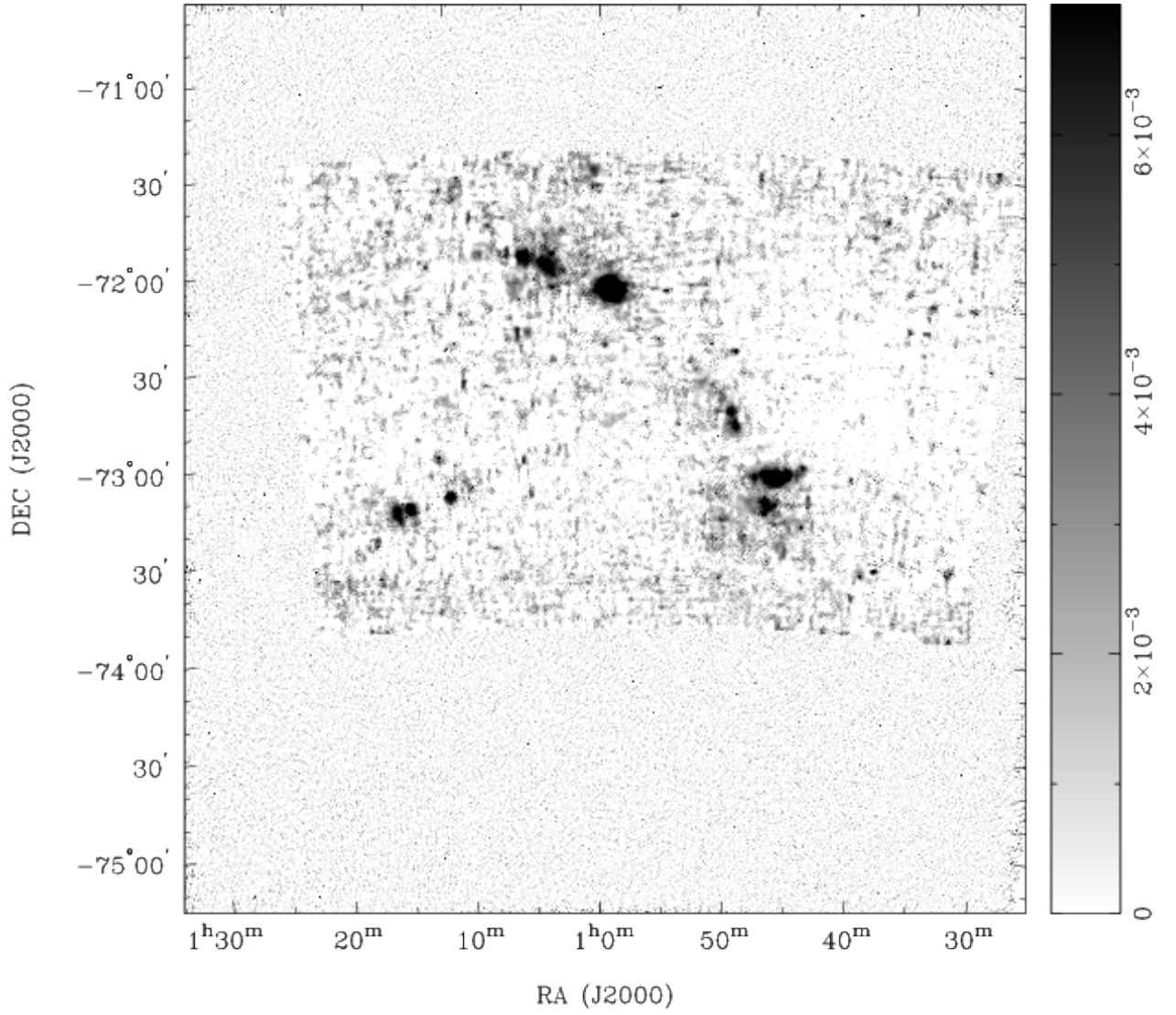


Fig. 4. The SMC at 3 cm with zero-spacing data. The map has a resolution of 20''. The sidebar gives the intensity scale in units of Jy/beam. The zero-spacing data does not cover the same spatial area as the interferometer data.

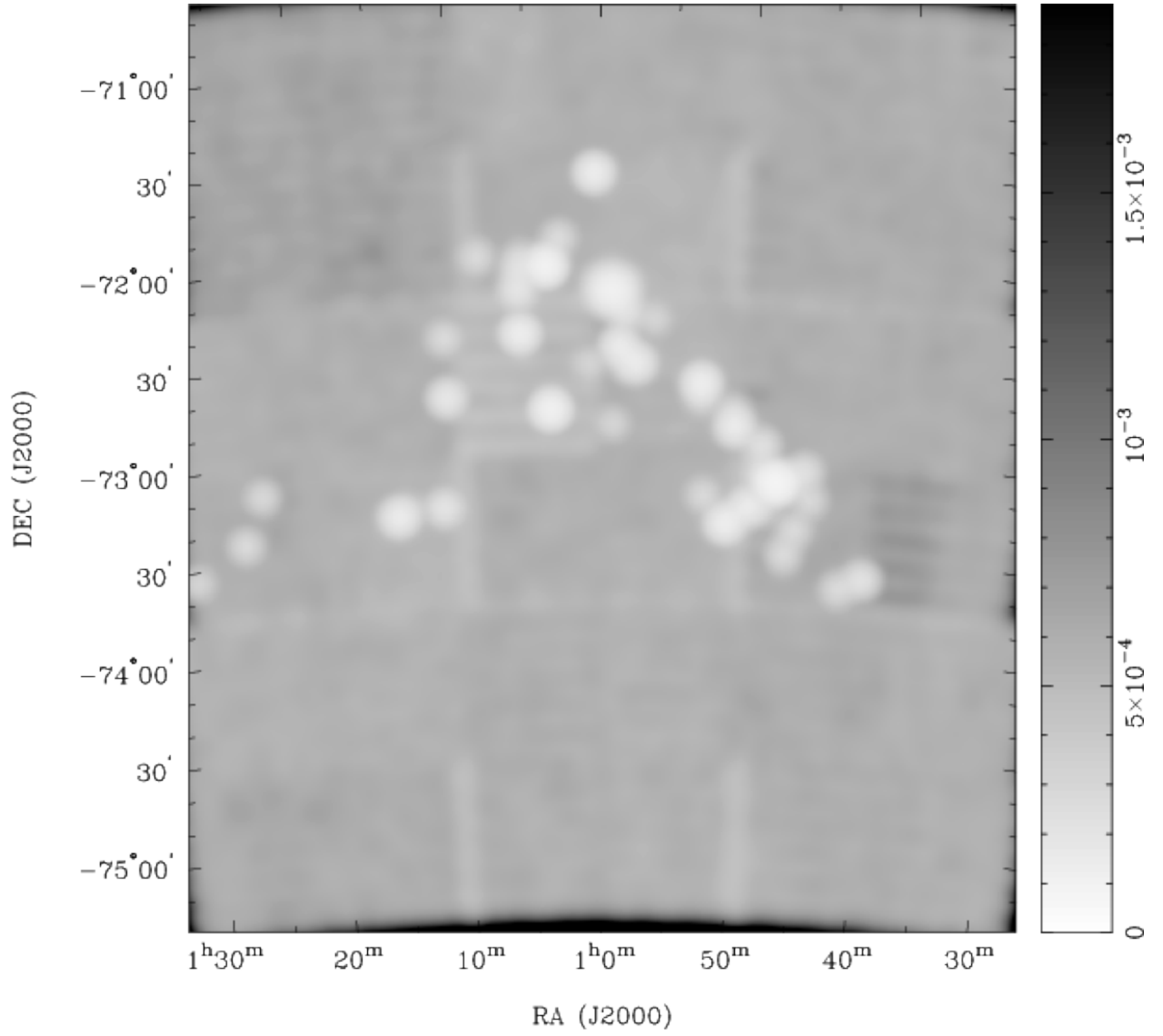


Fig. 5. *Theoretical r.m.s. sensitivity map of the 6 cm data used in this study in Jy/beam. Lighter areas indicate higher sensitivity.*

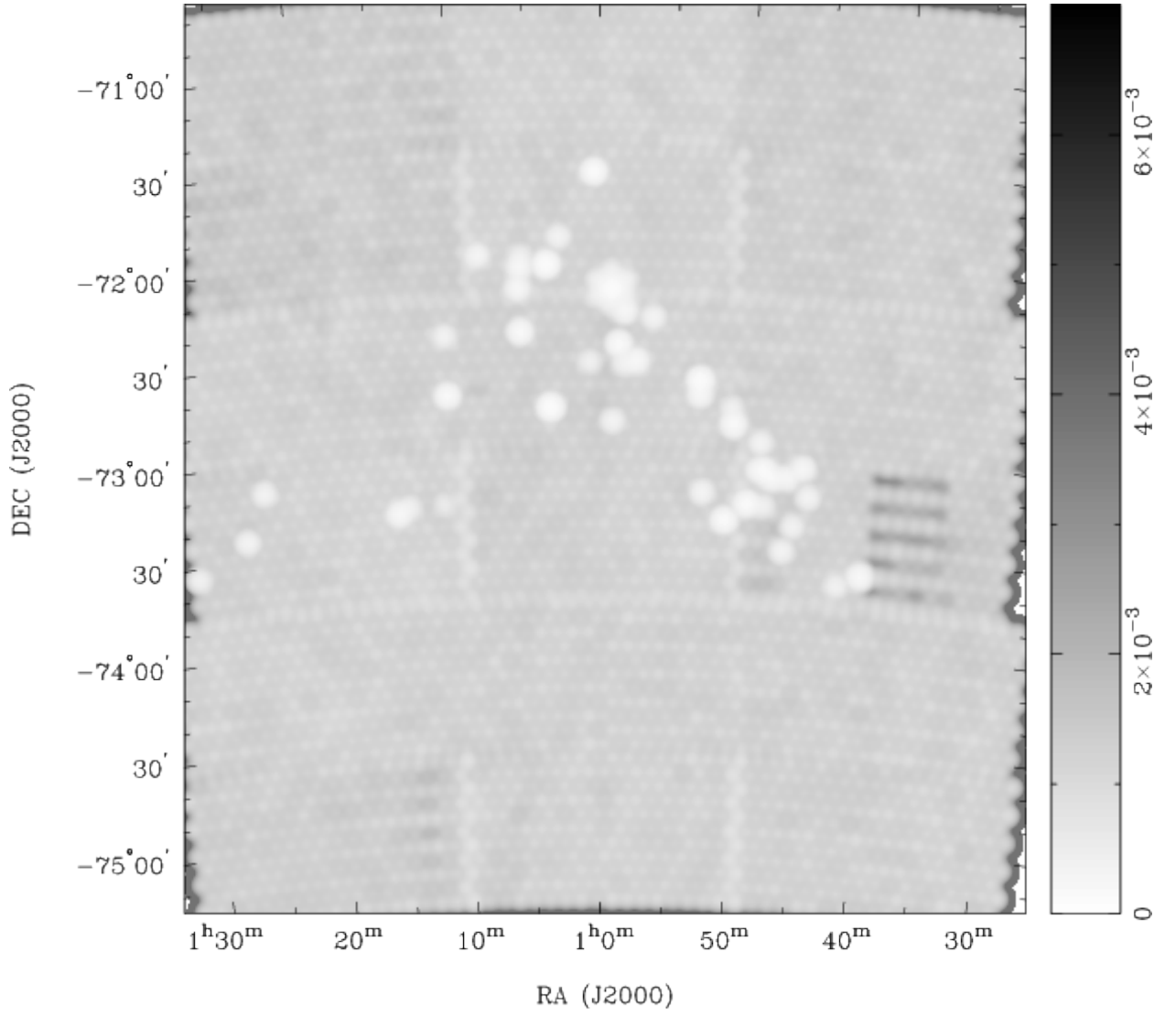


Fig. 6. *Theoretical r.m.s. sensitivity map of the 3 cm data used in this study in Jy/beam. Lighter areas indicate higher sensitivity.*

**НОВО ПРОУЧАВАЊЕ МАЛОГ МАГЕЛАНОВОГ ОБЛАКА
У РАДИО-КОНТИНУМУ НА 6 ЦМ И 3 ЦМ: ДЕО I - МАПЕ**

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У овој студији представљамо нове АТСА резултате посматрања високе резолуције и осетљивости у радио-континуму Малог Магелановог Облака (ММО) на $\lambda=6$ cm ($\nu=4.8$ GHz) и $\lambda=3$ cm ($\nu=8.64$ GHz). Нове радио-мапе настале су спајањем архивских мозаик посма-

трања тзв. “peeling” техником и то на 6 cm и 3 cm. Наше нове мапе имају резолуцију од $\sim 30''$ (6 cm) и $\sim 20''$ (3 cm) и осетљивост од r.m.s.=0.7 mJy/beam. Ове мапе ће бити коришћени у будућим истраживањима како објеката тако и укупне структуре ММО-а.